Environmental monitoring of insecticide spraying against the spruce budworm in Québec, 1985

FENITROTHION RESIDUE IN THE AIR OF THREE MUNICIPALITIES OF THE GASPÉ-LOWER ST.LAWRENCE REGION

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ABSTRACT

In its sixteenth aerial insecticide spraying operation against the spruce budworm (Choristoneura fumiferana), the ministère de l'Energie et des Ressources carried out in 1985, for the third year, a study aimed at determining the concentrations of chemical insecticide in the air of three municipalities of the Gaspé-Lower St.Lawrence region. In all, 134 air samples were collected over a 24 hour period between May 29 and August 26 at Rivière-du-Loup, Grande-Cascapédia and Val-d'Espoir. At Saint-Patrice de Rivière-du-Loup, the absence of fenitrothion (<1.4 ng-min/l of air) seems to indicate that the operational base does not contaminate the air of this municipality. For the other two villages, sample analysis showed very weak concentrations of fenitrothion varying from <1.4 ng-min/l to 10.0 ng-min/l (0.007 ng/l). These results are in agreement with those of a similar 1984 study in which all samples contained less than 14 ng-min/l (0.01 ng/l) of fenitrothion.

From the results of this study, it appears that the insecticide can drift for more than 50 km and even 100 km from treated areas, but the concentrations are very weak and unlikely to represent a danger for public health.

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1. INTRODUCTION

In accordance with its program of controlling harmful insects in the forest environment, the ministère de l'Énergie et des Ressources carried out in the spring of 1985 its 16th aerial insecticide spraying operation in order to reduce damage caused by the spruce budworm (Choristoneura fumiferana).

Within this context the department carried out for a fourth consecutive year a sampling program to determine insecticide concentrations in the air after spraying. One part of this program was to determine product drift outside the target area by measuring chemical insecticide concentrations (fenitrothion) in the air of three municipalities of region 01.

This report presents the results obtained in this study. The other parts of the program, including biological insecticide measurements or those carried out inside the treated areas, are dealt with in other reports.

2. TERRITORY

The spraying in 1985 covered a surface of 667 418 hectares in various regions including the Saguenay-Lac Saint-Jean, the Côte-Nord, Québec, the Lower St.Lawrence and Gaspé (fig.1). Of this area 482 963 ha (72.4%) have been treated with biological insecticide and 184 455 ha (27.6%) with the chemical insecticide fenitrothion, which is the subject of this report.

3. METHOD

3.1 Spraying

The chemical spraying program was carried out from June 12 to July 5 with Constellation L-749, DC-4G and DC-6 four-engine aircraft guided by Litton^{MD} inertial navigation units. The spraying system installed on these aircraft consisted of booms fitted with #8010 flat jet nozzles. A second application after about five days was planned for the chemical spraying but several blocks only received a single application due to a sizeable decrease in larvae populations after the first application.

3.2 Insecticide formulation

The chemical insecticide was fenitrothion (Sumithion^{MD}) sprayed at a rate of 210 g of active ingredient per hectare to give a final volume of 1.4 l/ha.

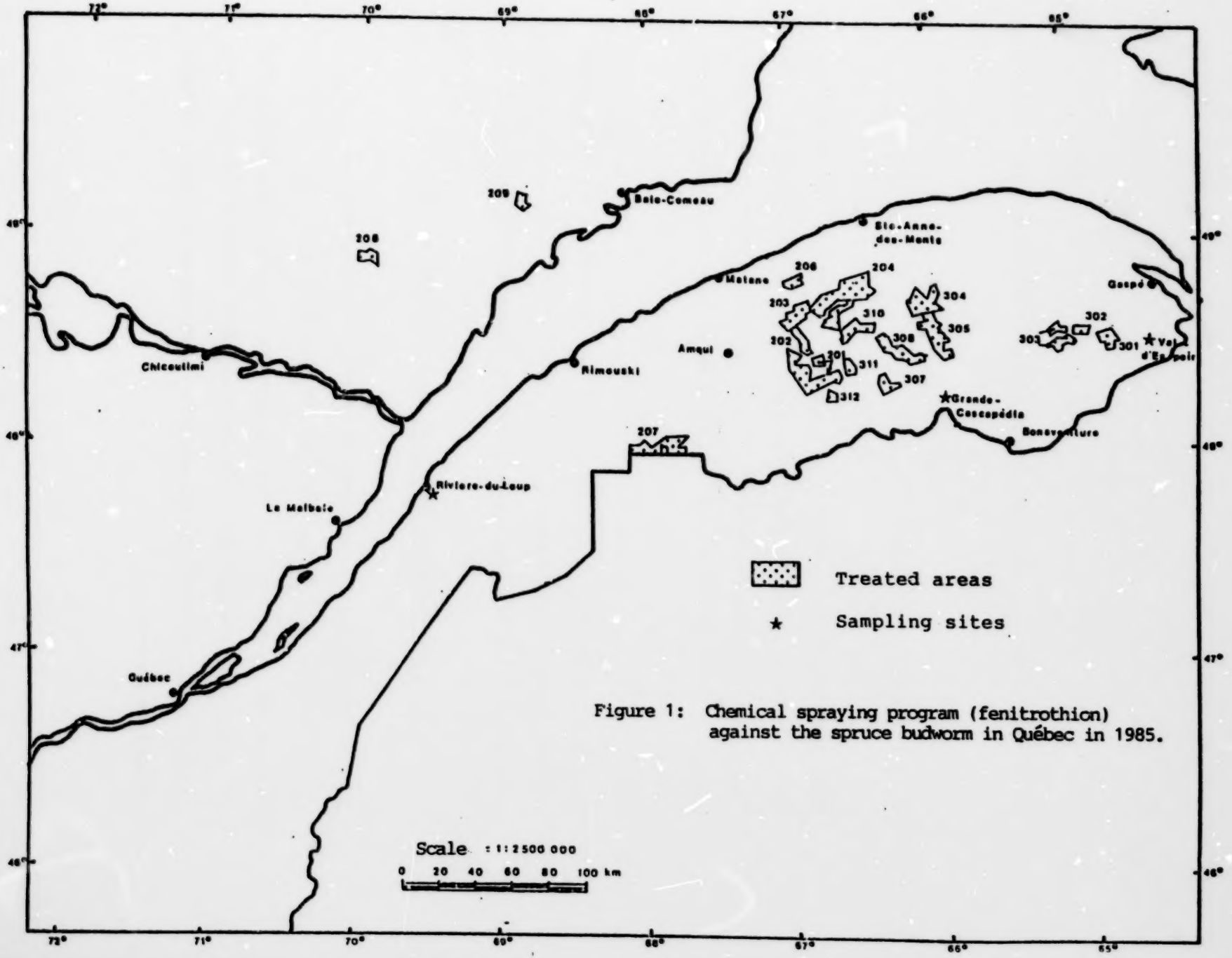


Figure 1: Chemical spraying program (fenitrothion) against the spruce budworm in Québec in 1985.

The proportion of each ingredient in the final mixture is indicated in table 1.

3.3 Air sampling

Three municipalities of region 01 were subject to this air sampling program: Saint-Patrice de Rivière-du-Loup, Grande-Cascapédia and Val d'Espoir. The first place was chosen because of its proximity to the department's operational base while the other two are located close to chemical spraying blocks.

At each of these places the sampling site was located in the backyard of private houses on open, relatively flat land. The minimum distance from these sites to the nearest treated blocks was 25 kilometers (fig.1).

Saint-Patrice de Rivière-du-Loup (47°47' N, 69°34' W)

The site was located 3.8 km northwest of the Rivière-du-Loup base (airport) halfway between the base and the town of Rivière-du-Loup. The aim of the sampling was to measure the possible presence of insecticide coming from stocks stored at the base and to a lesser degree to determine the drift from treated areas. In fact, the closest spray block was at a distance of about 125 km from the site.

TABLE 1: Formulation of chemical insecticide sprayed in Québec in 1985.

Active matter (commercial product)	Rate* (g/ha)	Formulation volume (1/ha)	Formulation V/V			
			Commercial product (%)	Cyclosol 63 (%)	Diluent** (%)	Dye (%)
Fenitrothion (Sumithion[MD] 95%)	210	1.4	12	40	47.5	0.5

* active ingredient
** oil 585

Grande-Cascapédia (48°14'N, 65°54'W)

Located within the village limits, the site was 2.6 km south of the town hall. The closest spray block was located 33 km away.

Val d'Espoir (48°30'N, 64°26'W)

The site was located 2.3 km southwest of the village and 25 km from the closest spray block.

In all, 42 air samples were collected at each of the last two sites between May 30 and July 11. At the Saint-Patrice site, which was different because of its proximity to the operational base, 43 samples were collected between May 29 and July 11 and then a sample each week until August 26 for a total of 50 samples. The sampling over a period of 24 hours was carried out by a Sierra-Misco^{MD} model 88 sampling apparatus with a flow rate of 40 l/min. An impinger containing 100 ml of ethylene glycol was connected to each of the pumps and removed the fenitrothion. A piece of glass wool is placed in the tube connecting the impinger to the pump to stop the ethylene glycol vapour from escaping and thereby avoiding a possible loss of insecticide. Tests made in 1984 on this sampling system showed an average retention effectiveness of 95% for fenitrothion (Major et al., 1984a).

At the end of each 24 hour sampling period, the ethylene glycol and the glass wool are put into a glass bottle and kept in a freezer for later analysis. All the glassware in contact with the insecticide is rinsed twice with water and chloroform. These wash solutions then become part of the sample. Before using the impinger again for the subsequent sample, the glassware is washed twice in water, acetone and chloroform.

3.4 Analytical method

The ethylene glycol is mixed with 1 500 ml of purified water in a 2 liter separatory funnel and then 20 ml of a solution saturated with sodium sulfate is added. The sample bottles and the glass wool are rinsed in 150 ml of chloroform and the wash solution is poured into the separatory funnel. The contents are stirred for two minutes and left to sit until the liquid phases separate. The organic phase is poured off into a 500 ml volumetric flask and extraction is repeated with 50 ml of chloroform. The organic extract is then dried out by filtering through 100 g of sodium sulfate in a buchner funnel equipped with fritted glass using a vacuum pump. The concentrate is then reduced to about 1 ml to which is added approximately ten ml of benzene, and again reduced to a volume of 2-3 ml. The final concentrate is poured into a 15 ml centrifuge tube and the final volume is adjusted to 5 ml. The identification and quantification were carried out with a Hewlett Packard[MD] model 5730A gas chromatograph equipped with two detectors for nitrogen and phosphorus (NPD).

Pyrex columns with a length of 180 cm and an interior diameter of 2 mm are used. They are saturated with 4% OV-101 + 6% OV-210 on Gas Chrom Q (80-100 mesh) for identification and with 3% OV-17 on the same support for confirmation. The temperatures of the various compartments and the gas flow are as follows:

- Temperature:		furnace	190
(^{o}C)	:	injection	250
	:	detection	300
- Gas flow	:	helium	30
(ml/min)	:	air	70
	:	hydrogen	3

4. RESULTS

Table 2 presents the results obtained each day at each of the three municipalities throughout the spraying program. These results are expressed in time-integrated concentrations(1) and the units are nanogram-minutes per liter of air.

4.1 Saint-Patrice de Rivière-du-Loup

Of the 50 samples collected between May 29 and August 26,1985, none showed detectable concentrations of fenitrothion in the air (<1.4 ng-min/l or <0.001 ng/l).

4.2 Grande-Cascapédia

Fenitrothion was detected in 7 of the 42 air samples collected here. The concentrations, which were very weak, varied from 1.4 to 10.0 ng-min/l.

4.3 Val-d'Espoir

During the 42 days of sampling, only two fenitrothion concentrations were detected: 7.2 and 10.0 ng-min/l on two consecutive days.

(1) The integrated concentration is obtained by dividing the total mass of insecticide in the sample (ng) by the flow rate of the sampler (l/min).

Table 2: Analytical results of air samples collected in three municipalities of the Bas Saint-Laurent-Gaspésie region in 1985.

	FENITROTHION ng-min/l		
DATE[1]	Saint-Patrice de Rivière-du-Loup	Grande-Cascapédia	Val-d'Espoir
85-05-29	N.D.[2]	-	-
30	N.D.	N.D.	N.D.
31	N.D.	N.D.	N.D.
06-01	N.D.	N.D.	N.D.
02	N.D.	N.D.	N.D.
03	N.D.	N.D.	N.D.
04	N.D.	N.D.	N.D.
05	N.D.	N.D.	N.D.
06	N.D.	N.D.	N.D.
07	N.D.	N.D.	N.D.
08	N.D.	N.D.	N.D.
09	N.D.	N.D.	N.D.
10	N.D.	N.D.	N.D.
11	N.D.	N.D.	N.D.
12	N.D.	N.D.	N.D.
13	N.D.	N.D.	N.D.
14	N.D.	N.D.	N.D.
15	N.D.	4,3 (3 ng/m^3)	N.D.
16	N.D.	1,4 (1 ng/m^3)	N.D.
17	N.D.	N.D.	N.D.
18	N.D.	N.D.	N.D.
19	N.D.	N.D.	N.D.
20	N.D.	2,8 (2 ng/m^3)	N.D.
21	N.D.	N.D.	N.D.
22	N.D.	N.D.	N.D.
23	N.D.	N.D.	N.D.
24	N.D.	N.D.	N.D.
25	N.D.	N.D.	N.D.
26	N.D.	N.D.	N.D.
27	N.D.	N.D.	N.D.
28	N.D.	N.D.	N.D.
29	N.D.	N.D.	N.D.
30	N.D.	N.D.	7,2 (5 ng/m^3)
07-01	N.D.	2,8 (2 ng/m^3)	10,0 (7 ng/m^3)
02	N.D.	4,3 (3 ng/m^3)	N.D.
03	N.D.	N.D.	N.D.
04	N.D.	10,0 (7 ng/m^3)	N.D.
05	N.D.	N.D.	N.D.
06	N.D.	2,8 (2 ng/m^3)	N.D.
07	N.D.	N.D.	N.D.
08	N.D.	N.D.	N.D.
09	N.D.	N.D.	N.D.
10	N.D.	N.D.	N.D.
16	N.D.	-	-
23	N.D.	-	-
30	N.D.	-	-
08-07	N.D.	-	-
15	N.D.	-	-
20	N.D.	-	-
28	N.D.	-	-

(1) Date of the beginning of sampling
(2) N.D.: not detected (<1.4 ng-min/l)

5. DISCUSSION

The results obtained at Saint-Patrice de Rivière-du-Loup show that the proximity of the operational base does not result in detectable concentrations of fenitrothion in this municipality in spite of the presence of large quantities of this product and ongoing operations. These results confirm those of a similar study in 1984 at the same site. No detectable concentration of aminocarb or fenitrothion was observed at the time (Major et al., 1984b). We should mention however that the detection limit was higher (0.01 ng/l or 14 ng-min/l). It would therefore appear that the precautions taken in storing and handling this product permit to avoid any contamination of the air of Saint-Patrice.

For the other two municipalities, we present the results in figures 2 (Grande-Cascapédia) and 3 (Val-d'Espoir) in order to visualize the variability of concentrations and the possible relationships between these and the occurence of spraying in neighbouring sectors. Looking at these figures, the distance between the treated areas and the air sampling sites is not the only factor influencing the concentrations found in the villages. Concentrations have been detected after spraying at more than 50 km (fig.2) and even 100 km (fig.3) from the sites. The amount of sprayed product, which increases with the surface, is also an element that can influence the importance of drift. This information presented in figure 4 shows a certain

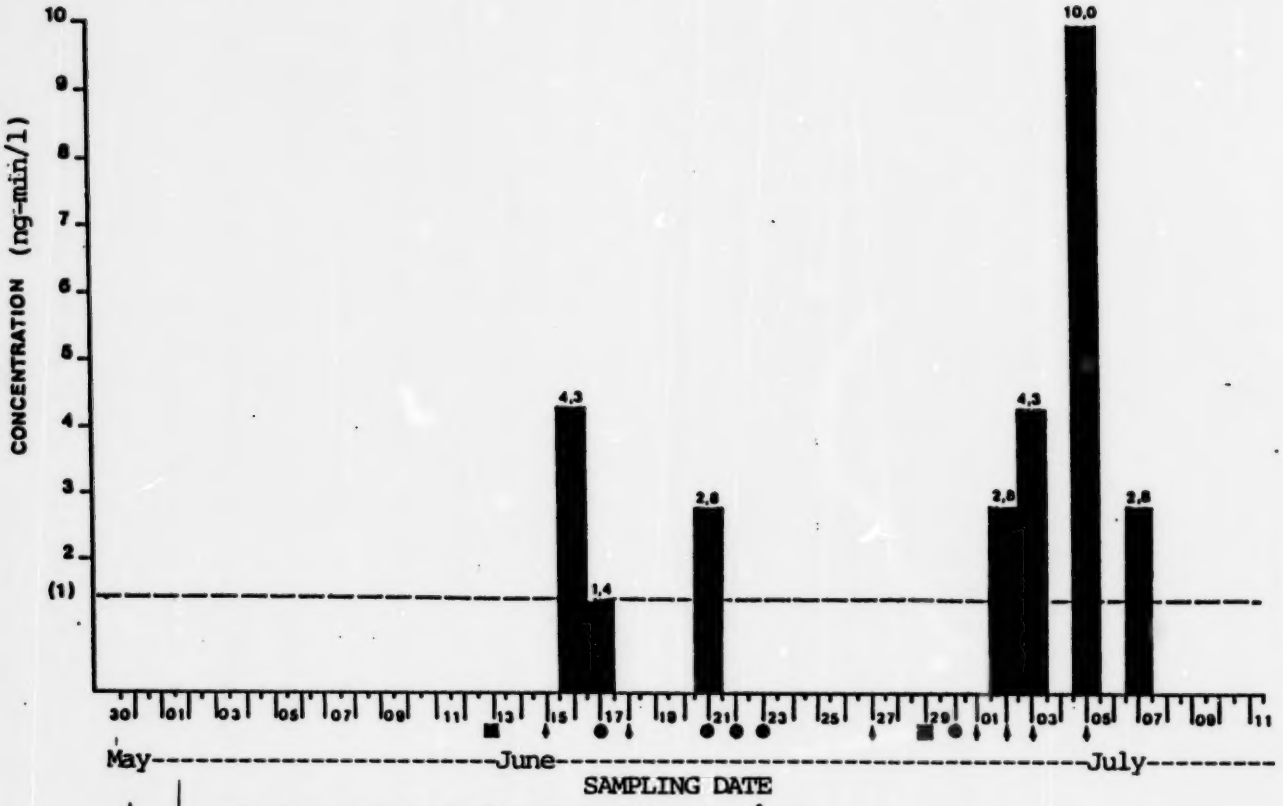
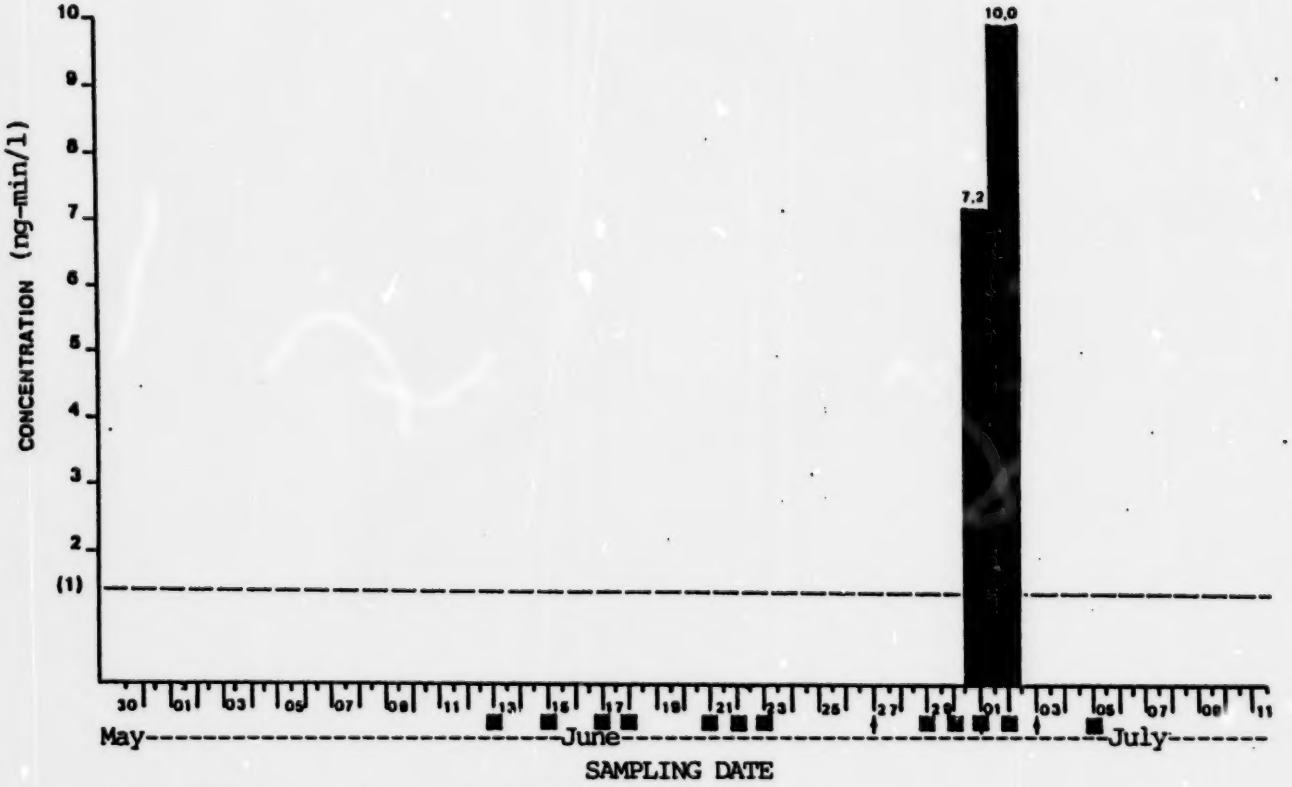


Figure 2: Histogram of fenitrothion concentrations at Grande-Cascapédia during spraying against the budworm in 1985



Spraying at less than 50 km from the site
" between 50 and 100 km from the site
" at more than 100 km from the site
(1) Detection limit (n.d <1.4 ng-min/l)

Figure 3: Histogram of fenitrothion concentrations at Val d'Espoir during spraying against the budworm in 1985

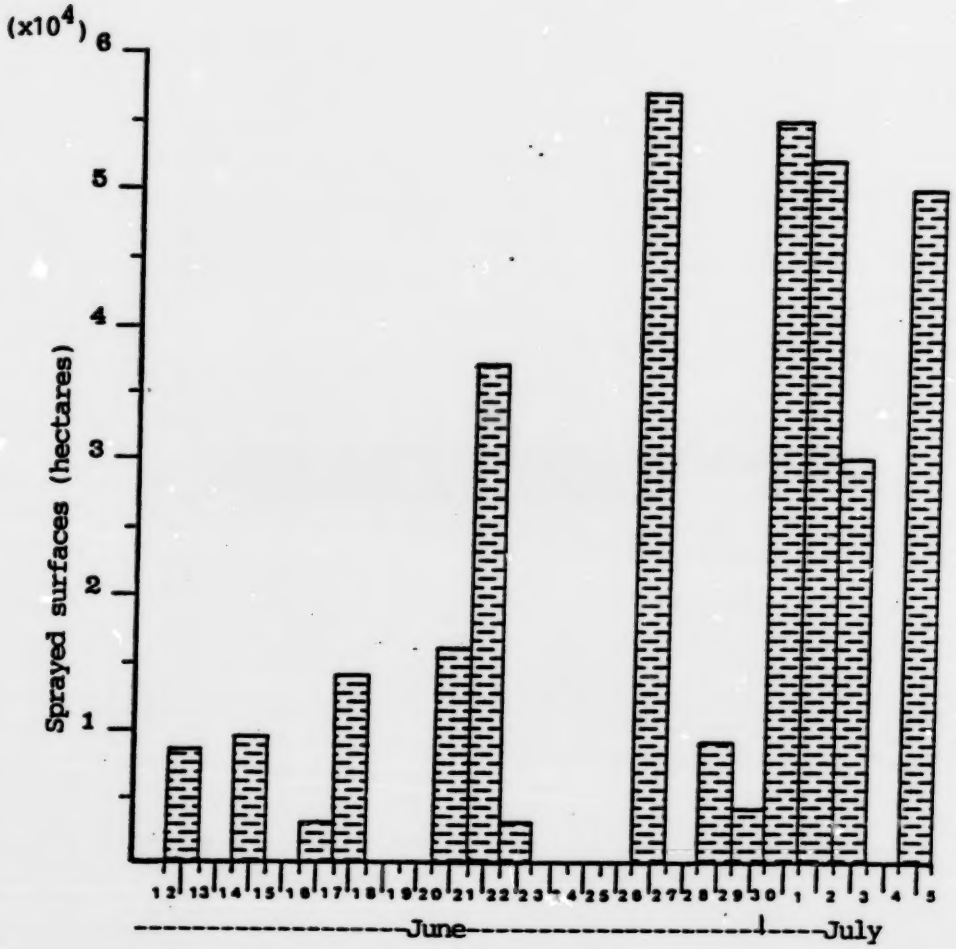


Figure 4: Histogram of treated areas during each day of sampling (ex: 8000 hectares were treated for the period of June 12 p.m. and June 13 a.m.)

correspondence between the concentrations detected at the end of June and at the beginning of July in both municipalities.

We also tried to establish a connection with a major factor, wind speed, but this relationship although evident was impossible to demonstrate. In fact, contradictory wind speed values were observed at the treated areas (observations of aircraft supervisors) and the meteorological stations of Environment Québec near the sampling sites. These discrepancies can be explained by distance and topographical differences between treated areas located in mountainous terrain and sampling sites in villages on the shore.

In figure 2 there are two interesting phenomena. After spraying on the morning of June 15, the insecticide was detected at Grande-Cascapédia during the following period starting at noon on the 15th. This could be due to a very light wind or a greater evaporation of fenitrothion in the middle of the day when the temperature is at a maximum. We also detected fenitrothion beginning on July 6 when the last spraying occurred on July 4. We should mention that July 6 was a very hot day with a maximum temperature close to 30°C. It is therefore possible that there was evaporation of the insecticide in the treated area and subsequent transport of this vapour. It is also possible that there was evaporation of the product deposited close to the pump after the concentration found on July 4.

One should remember that the fenitrothion concentrations detected in the air of both municipalities are very weak and would not have been noticed if the very low detection limit had not been employed this year. In 1984, the detection limit was 0.01 ng/l and this concentration was not considered to be a risk to the health of the population (Major et al., 1984b). We continue to believe this in 1985 since the concentrations were even lower than the above detection limit.

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